

# PROPHYLACTICS

IN CHARGE OF  
MARY M. RIDDLE

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## THE RELATION OF BACTERIOLOGY TO PREVENTIVE MEDICINE

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(Continued)

No disease of modern times has a greater influence on the death-rate than consumption, and thanks to bacteriology its infectious nature is now fully established. The hereditary nature of the disease is not now admitted to any considerable extent, and the existence of many cases of supposed hereditary transmission can be fully explained by infection. It is an interesting fact bearing on the prevalence of this disease that there are more deaths from consumption each year in Boston than there are cases of scarlet fever, one of the most infectious of diseases. The cutaneous manifestations of tuberculosis have not until within a few years attracted much attention, but recently this subject has been very carefully investigated not only by dermatologists but also by the profession at large. It has been proved that tubercular disease of the skin is extremely frequent, and it has also been shown that the infection is derived from the sputum of persons ill of phthisis. Thus far very little has been done in the way of limiting the frequency of the disease, but there is much for boards of health to accomplish in this direction. The degree of infectiousness of a disease has a very important bearing on the method of diminishing its frequency. The source of danger in consumption is the sputum, particularly when in a dry state, and for this very reason all sputa should be carefully disinfected as soon as expectorated. There is no proof that a person ill with phthisis can communicate the disease either by contact or through the air, but every attempt should be made to disinfect the sputum by the best-known methods. The use of sanitary sputum-cups, made of paper, which can be burned, now in use in every hospital should be earnestly advocated by the profession, and, in addition, all handkerchiefs and cloths soiled by the expectoration should be

either burned or disinfected by carbolic acid or some other equally good agent. As this bacillus remains active for a long time when in a dried state, the importance of watering the streets is self-evident. Dust is one of the best agents for carrying disease, and therefore the watering of streets is much more important from a sanitary point of view than from any other.

Much has been said and there has been much acrimonious disputation during the past year in this vicinity regarding the transmission of tuberculosis by milk. That this does occur, and that it has occurred, has been established beyond a doubt. The work of the cattle commissioners in endeavoring to stamp out tuberculosis in cattle, or at least to diminish its frequency, although it has received much adverse criticism, has accomplished a certain amount of good.

The bacillus of tuberculosis was discovered by Koch in 1882, and the announcement of his discovery was made at the meeting of the Physiological Society of Berlin in March of the same year. The importance of this discovery on the etiology and pathology of the disease cannot be overestimated. This bacterium is a rod with rounded ends from one to three and five-tenths micromillimetres in length. This bacillus is extremely difficult to cultivate, but by careful attention to technique and proper care culture medium can be successfully grown. The importance of this organism as a means of early diagnosis is very great. It can be stained, in the sputum of patients, very readily without the necessity of cultivation, as is the case with the other pathogenic organisms. The method adopted by Koch and modified by Ehrlich, and known as the Koch-Ehrlich method, is the most satisfactory way of staining. It consists in placing upon cover-glasses a minute portion of the sputum. It is important to select the small lenticular masses so frequently seen in tuberculous sputum. These masses are crushed by rubbing the cover-glasses together and then are allowed to dry in the air. They are then placed in an alcoholic solution of fuchsin to which a certain amount of aniline-water has been added for twenty-four hours, at the end of which time the cover-glasses are washed and decolorized with nitric acid, one part to three for sections, one part to four for cover-glasses, and are then washed and counter-stained with a watery solution of methylene blue and mounted. When examined it will be seen that the tubercle bacilli are stained red and that the other organisms are stained blue. Ziehl's method of staining may be used in certain instances where it is impossible to wait twenty-four hours, but the disadvantage of Ziehl's method is the fact that if the bacilli are few in number they may not be detected. In the same specimen of sputum a negative result may be reached with the Ziehl method and a positive one with the Koch-Ehrlich. The Ziehl

method consists in using a solution of fuchsin and carbolic acid for half an hour with the addition of heat. The subsequent steps are similar to those in the Koch-Ehrlich. The tubercle bacillus is a strict parasite, and while it does not multiply to any very considerable extent outside the body, yet it retains its vitality for a very long time, and under favorable conditions will multiply very rapidly. Koch, Schill, and Fischer found that these bacilli retained their vitality in dried sputum for from nine to ten months. Malet in his experiments with the dried parts of the lung from a tuberculous cow produced tuberculosis with this material in guinea-pigs at the end of one hundred and two days. The organisms also may retain their vitality from forty to fifty days in putrefying material, or according to other observers one hundred and twenty days. The gastric juice does not destroy this organism, as has been shown by the experiments of Baumgarten and Falk. A three-per-cent. solution of carbolic acid destroys these organisms in sputum in about twenty hours, according to Schill and Fischer. Yersin's experiments with the bacillus of tuberculosis show that this organism was killed by a five-percent. solution of carbolic acid in a very short time. Absolute alcohol destroyed the organism in five minutes, mercuric chloride, one part to a thousand, was fatal to the organism in ten minutes, salicylic acid, two and one-half per cent., in six hours. The action of sunlight on the tubercle bacillus is very marked. Koch says that when this organism is exposed to the direct rays of the sun it is killed in from a few minutes to several hours, according to the thickness of the layer. It is also destroyed by diffuse sunlight in from five to seven days when placed near a window. Von Esmarch has shown by his experiments that when pure cultures of this bacillus are placed upon white cloth and exposed to the sunlight they are killed in a few hours. That when similar cultures are placed upon black cloth a greater length of time is required to destroy them. The action of sunlight on this organism as well as on all other pathogenic organisms has an important hygienic bearing. The disinfectant action of sunlight has thus far not received sufficient attention. The desirability of sunlight in dwellings and hospitals while it has been advocated on general principles has not until comparatively recently, due to the work of the bacteriologists, been placed on a strict scientific basis. In Bowditch's investigations on consumption in Massachusetts he found that consumption was much more prevalent in houses where the sunlight was excluded, to a considerable degree, by shade-trees, and also where there was a certain amount of dampness; in fact, where all the conditions were suitable for the growth and retention of the vitality of the organism. It is also a significant fact that tuberculosis is much more common in cattle confined in dark, damp stables.

Although leprosy is a rare disease with us, yet it is important to recognize it not only clinically but also from a bacteriological standpoint. Hansen in 1879 discovered a bacillus in the interior of the round cells found in leprous tubercles. Neisser and many other observers confirmed this discovery. The bacillus of leprosy resembles the tubercle bacillus in form, but is of more uniform length and is not so generally bent or curved. This organism can be stained by the aniline colors. The best method of staining for purposes of diagnosis is that used for the tubercle bacillus which has been already described. Many attempts have been made to grow this organism artificially, but they have not been very successful. Recently, however, it has been stated in the report of the India Leprosy Commission that a successful cultivation of the leprosy bacillus in blister-serum has been accomplished. The opinion that this bacillus is the cause of leprosy has been derived from deduction rather than from actual inoculation of pure cultures. It has been shown, however, that tissues containing this organism are infectious. Arning in the Sandwich Islands inoculated a condemned criminal with fresh leprous tubercles containing immense numbers of these bacilli. The man was under observation until his death from leprosy five years after the inoculation. The disease manifested itself first about five months after inoculation near the point of insertion of the infectious material. In the lower animals certain observers have had positive results with the inoculation of leprous tubercles.

Glanders has been shown to be due to a certain specific organism, and the importance of a positive diagnosis in doubtful cases of the disease for the purpose of isolation is very great. This organism was discovered by Löffler and Schütz in 1882, and is described by them as a rather short bacillus with rounded ends. This organism is an aërobic non-motile parasitic bacillus, and stains readily with the usual aniline colors. Mallein obtained from pure cultures of the glanders bacillus gives us an agent of great diagnostic value. It has been found that the inoculation of animals with this preparation in the incipient stages of glanders has been followed by a very decided and marked reaction which does not occur in healthy animals. Although as yet we have not an "anti-mallein" for the cure of the disease, yet the etiology of the disease has been elucidated, and we also have an agent, thanks to bacteriology, that is of great practical value from a diagnostic point of view.

Typhoid fever, the frequency of which is so great in the towns and smaller cities, has been demonstrated to be due not so much to infection from the patients themselves as to a polluted water-supply and milk-supply. Valuable as a chemical analysis of the water-supply is, the value of a bacteriological examination of the water is much

greater. Eberth in 1881 and 1882 demonstrated the presence of the bacillus in the spleen and diseased glands of the intestines of patients dead of typhoid fever. Gaffky first obtained pure cultures of this organism and described its principal biological characters. This organism is a small bacillus and is motile. The organs of motility are numerous flagella arranged around the periphery of the organism. This bacillus stains with the usual aniline colors. This organism grows in the presence of oxygen and does not liquefy gelatin, which latter is an important point in differentiation. As this organism resembles many others in shape, it is impossible to differentiate it without careful and peculiar methods of cultivation. The fact that it does not liquefy gelatin, that when grown in litmus agar and litmus bouillon containing two per cent. of glucose there is no formation of gas and no change in the color of the litmus, are some of the methods by which the organisms can be detected. The importance of a bacteriological investigation of the water-supply has been fully demonstrated by the results of the work of the State Board of Health of Massachusetts at the experimental station at Lawrence. It was found that an increase of the number of cases of typhoid fever in Lowell, which drains into the Merrimac River, could be demonstrated by the increase in the number of bacilli of typhoid fever found in the river-water at Lawrence. There are many instances on record where well-water sufficiently pure, chemically speaking, for domestic use was found to be loaded with the bacilli of typhoid fever. In fact, a well placed as it generally is in the country, where it of necessity receives the drainage from the house, if the water becomes contaminated with the germs of typhoid fever, forms one of the most fertile means of spreading the disease. It is, in fact, a culture tube on a large scale. This not only emphasizes the necessity for disinfecting the excreta of typhoid fever patients, but it also shows the importance of placing wells at a considerable distance from the dwellings and on a higher plane. It has been found that the bacillus of typhoid fever dies after a short time in river-water, but lives long enough to cause the disease in susceptible individuals. The longest period of time that this organism has been known to live in river-water placed in test-tubes is twenty-four days. The advantages of purification of water by sand filtration has been fully demonstrated by the work of the bacteriologist. It has also been shown that in order that the filter may be effectual it must be constructed under certain definite rules, and when constructed according to these definite rules even the most polluted water is made safe for domestic use. Probably no city in the world had more cause to lament a polluted water-supply than Hamburg, but owing to the severe lesson of the cholera epidemic her water-supply is now of the best. Hamburg has at the

present time the most complete and well-equipped water-works of any city in the world. The water is taken from the Elbe and is submitted to rock and sand filtration, so that the organic matter and most of the bacteria are removed. A corps of trained bacteriologists examine the water as it comes from the filters three or four times in the course of the twenty-four hours. If the number of organisms is above a certain percentage the water from that particular filter is not used, but the filter is discontinued for a certain length of time until it has been cleansed and the water from a second filter is used. If Hamburg had had this system eight years ago she would not have been visited by the tremendous epidemic of cholera. It is also a significant fact that since the introduction of the new water-supply at Hamburg the number of cases of typhoid fever in that city has been diminished to a marked degree. The city of Altona, situated below Hamburg and taking its water from the river Elbe, while it had not so extensive and elaborate a system of water-works as Hamburg now has, was supplied with comparatively pure water, and the result was that while Hamburg eight years ago, before the introduction of the new water-works, suffered from cholera in a marked degree, Altona was comparatively free from the disease. No system of water-supply should be considered complete without a bacteriological laboratory connected with it,—a laboratory sufficiently well equipped with men and materials to carry on not only the routine work but also to engage in experimental research. There are many problems regarding a water-supply that should be solved: the question of purification by the air; the life-history of the various bacteria in water; the structure of the filters, not only the material of which they are composed, but the manner in which they are built, and many other questions that it is unnecessary to enumerate.

The effect of freezing on the bacillus of typhoid fever has been carefully studied by various bacteriologists, and it has been absolutely demonstrated that cold does not kill the organism although it does inhibit its growth. This has an important bearing upon the ice-supply. Ice taken from a pond contaminated with the discharges from typhoid fever patients when used may communicate the disease. The importance, therefore, of some supervision of ponds and rivers from which ice is taken is apparent.

(To be continued.)